ROYAL ASTRONOMICAL SOCIETY.

VOL. IX. *May* 11, 1849. No. 7.

G. B. AIRY, Esq., Astronomer Royal, President, in the Chair.

The Right Hon. the Lord Chief Baron;
John Fletcher Miller, Esq., Whitehaven;
Isaac Fletcher, Esq., Tarn Bank, near Cockermouth;
Lieut. Robt. Wm. Hall Hardy, R.N., Kilkenny House, Bath;
John Bennett, Esq., 65 Cheapside;
were balloted for and duly elected Fellows of the Society.

Letter from Professor Bond, Director of the Cambridge, U. S., Observatory, to the Secretary.

"It is purposed in behalf of the Coast Survey of the United States to attempt the determination of the difference of longitude between the Royal Observatory at Greenwich and the observatory at Cambridge, in the United States, by means of chronometers, transported by railroad from Greenwich to Liverpool, and from thence by the mail steamers to Boston.

"Professor Bache, the superintendent of the United States Coast Survey, has requested me to make the requisite arrangements for carrying this project into execution.

"It is intended to employ constantly during the season between thirty and forty select chronometers. There will be three principal stations, namely, Greenwich, Liverpool, and Cambridge; or, if Greenwich were connected with Liverpool by the magnetic telegraph, the stations, so far as the transmission of chronometers was concerned, might be reduced to Liverpool and Cambridge, and we are assured of the valuable co-operation of Mr. Hartnup, the director of the Liverpool Observatory.

"It being desirable that there should be uniformity of action in carrying on this work, Professor Bache has caused blank forms to be drawn up and printed for the use of the observers, and it is proposed that my son, R. F. Bond, who now visits England to select chronometers and make preliminary arrangements, should practise with those observers who would be likely to be engaged in this enterprise, in order to determine, as he has done with us, the amount of personal equation.

"The advice and assistance of the Astronomical Society of London would be valuable to us in regard to the transmission of the chronometers by the Royal Mail steamers. If you think that the project is worthy of its consideration, I shall be greatly obliged by your presenting the subject at the next meeting of that body."

DE GASPARIS' PLANET.

"Signor De Gasparis, of the Observatory of Naples, discovered a planet about 9·10 mag. on the 12th April last, while comparing Steinheil's Map (Hora xii.) with the heavens. Unfavourable weather prevented any exact determination that night, but on the 14th and 17th comparisons were made through other stars with No. 23098 of the *Histoire Céleste*,* which gave the results following :—

1849.	Naples M.T. h m s	R.A. m s	N.P.D. ′ ″
April 14	9 2 53	* − 0 30	* + 10 52
17	14 2 42	* − 2 59	* − 4 16

"The planet is retrograding and approaching the equator."—*From Professor Schumacher's Circular.*

Extract of a Letter from Professor Schumacher to the Astronomer Royal.

The following observations of Gasparis' Planet have been made at Berlin, Altona, Hamburg, and South Villa. The comparisons are with the places deduced from Encke's elements. The Mean Times are those of Berlin, Altona, Hamburg, and Greenwich, and are distinguished by the initial letter.

1849.		M. T. h m s	R.A. ° ′ ″	N.P.D. ° ′ ″	Correction to Elements. R.A. ″	N.P.D. ″
May 13	Prof. Encke	12 19 2·2 B	180 18 37·1	95 43 55·9		
15	,,	11 29 26·3 B	17 44·8	40 21·0		
17	Dr. Petersen	10 40 33·5 A	180 18 2·0	95 37 30·8	− 9·5	+14·0
	M. Sonntag	12 15 44 A	17 52·9	37 16·3	20·8	5·0
	M. Rümker	10 23 13·2 H	18 6·2	37 22·3		
18	Dr. Petersen	10 0 23·7 A	180 18 41·4	95 36 6·9	−14·7	+ 9·1
	,,	18 40·4 A	18 40·5	35 55·7	14·5	− 1·2
	M. Sonntag	25 46·0 A	18 38·7	35 59·6	16·2	+ 3·3
	M. Rümker	10 21 14·2 H	18 37·7	36 2·5		
20	Dr. Petersen†	10 0 25·2 A	180 21 8·0	95 33 40·4	−12 1	+ 2·0
	,,	31 29·3 A	21 2·1	33 47·6	20·1	10·3
	M. Sonntag	10 38 29 A	20 59·3	33 39·5	23·2	2·7
	M. Querling	11 36 7 A	21 4·6	33 38·0	−25·0	+ 3·6
	M. Rümker	10 19 22·0 H	21 0·1	33 36·8		
21	M. Sonntag	10 40 48 A	180 22 47·2	95 32 47·9		
	M. Rümker	10 16 48·7 H	22 37·5	32 44·5		
22	,,	10 28 35·5 H	24 35·5	32 4·4		
27	Mr. Hind‡	9 51 45 G	180 39 40·5	95 29 50·4		

* Epoch 1800.	Mag.	R.A. h m s	An. Prec. s	N.P.D. ° ′ ″	An. Prec. ″
Virgo	8½	12 9 48·64	+3·077	97 0 48·4	+20·04

† The planet faint in this comparison.

‡ Mr. Hind thought the planet rather fainter than 10 mag.

Elements.

Professor Schumacher has had the goodness to forward to the President, Professor Encke's elements of the newly-discovered planet. These elements are deduced from the observations of April 14, May 13 and 15, without taking Aberration, Nutation, Precession, Parallax into account.

Epoch 1849, May 13·5. Berlin M.T.

Mean longitude	211° 8′ 31″·1		
Anomaly	328 5 1·3		
Perihelion	243 3 29·8		
Node	286 34 31·1		
Inclination	3 46 5·9		
φ	9 50 36·8	e	0,170959
Log. a	0·5514044	Mean daily motion	601″·09

The Computed—Observed places are as follows :—

	$\Delta\alpha$	$\Delta\delta$	
	′ ″	″	
April 14	− 0·2	0·0	
17	−7 37·5	−11·8	error of 30^s in the observation.
May 13	0·0	− 0·1	
15	− 0·6	+ 0·3	
16	− 4·9	+ 3·2	

Ephemeris from Encke's Elements. By Mr. Graham.*

For Greenwich Mean Midnight.

1849.	R.A. h m s	N.P.D. ° ′	Hor. Par. ″	1849.	R.A. h m s	N.P.D. ″ ′	Hor. Par. ″
May 25	12 2 13	95 30·2	3·92	June 14	12 10 42	95 51·2	
26	2 28	29·9		15	11 20	53·6	3·54
27	2 43	29·9		16	11 58	56·1	
28	2 59	30·0	3·86	17	12 38	95 58·7	
29	3 7	30·2		18	13 19	96 1·5	3·49
30	3 36	30·5		19	14 0	4·4	
31	3 56	31·0	3·81	20	14 42	7·4	
June 1	4 17	31·6		21	15 26	10·4	3·44
2	4 40	32·3		22	16 11	13·7	
3	5 4	33·1	3·75	23	16 56	17·0	
4	5 29	34·1		24	17 42	20·4	3·39
5	5 55	35·3		25	18 29	24·0	
6	6 22	36·6	3·69	26	19 17	27·7	
7	6 51	37·9		27	20 7	31·4	3·34
8	7 21	39·4		28	20 57	35·3	
9	7 51	41·1	3·64	29	21 48	39·3	
10	8 23	42·8		30	22 40	43·3	3·30
11	8 56	44·7		July 1	23 33	47·5	
12	9 31	46·7	3·59	2	24 26	51·7	
13	12 10 6	95 48·9		3	12 25 20	96 56·1	3·25

* An ephemeris for every 4 days has been communicated by Mr. Breen of the Royal Observatory.

FLORA.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1849.	Greenwich M.T.	R.A.	N.P.D.	Compd—Obsd. R.A.	Compd—Obsd. N.P.D.	Star. B.A.C.
	h m s	h m s	° ′ ″	s	″	
May 3	11 50 15·2	14 5 26·40	92 50 14·2	+1·40	+10·8	4665–4748
4	10 56 36·1	4 30·23	46 44·4	1·73	10·7	,, ,,
5	12 9 37·2	3 30·16	43 5·0	1·43	10·7	,, ,,
7	12 40 5·4	1 36·16	36 30·1	1·56	12·0	,, ,,
8	10 16 3·6	14 0 46·42	33 48·7	1·65	10·7	,, ,,
11	12 11 51·3	13 58 2·17	92 25 31·7	+1·54	+11·0	,, ,,

"The places of the stars are taken from the catalogue cited. The observed places are corrected for refraction and parallax. The computed places are deduced from Dr. Brünnow's ephemeris, published in the present *Monthly Notice*."

Ephemeris. By Dr. Brünnow.

For Greenwich Mean Midnight.

Communicated by Professor Schumacher.

1849.	R.A.	N.P.D.	1849.	R.A.	N.P.D.
	h m s	° ′ ″		h m s	° ′ ″
April 1	14 35 28·41	95 32 55·5	April 26	14 12 27·21	93 19 36·2
2	34 44·59	27 30·0	27	11 26·32	15 3·3
3	33 59·42	22 2·3	28	10 25·62	10 37·3
4	33 12·95	16 32·6	29	9 25·20	6 18·9
5	32 25·21	11 1·3	30	8 25·11	93 2 7·9
6	31 36·26	95 5 28·7	May 1	7 25·42	92 58 4·7
7	30 46·15	94 59 55·2	2	6 26·20	54 10·0
8	29 54·90	54 21·2	3	5 27·51	50 23·5
9	29 2·57	48 46·9	4	4 29·42	46 45·8
10	28 9·23	43 12·7	5	3 31·97	43 17·1
11	27 14·93	37 38·9	6	2 35·24	39 57·6
12	26 19·71	32 6·1	7	1 39·27	36 47·3
13	25 23·65	26 34·6	8	14 0 44·12	33 46·7
14	24 26·78	21 4·7	9	13 59 49·85	30 55·8
15	23 29·19	15 36·7	10	58 56·51	28 14·9
16	22 30·94	10 11·3	11	58 4·14	25 43·9
17	21 32·08	94 4 48·5	12	57 12·80	23 23·3
18	20 32·70	93 59 29·0	13	56 22·54	21 13·1
19	19 32·86	54 13·1	14	55 33·40	19 13·2
20	18 32·63	49 1·2	15	54 45·42	17 23·9
21	17 32·09	43 53·7	16	53 58·65	15 45·4
22	16 31·30	38 51·1	17	53 13·12	14 17·7
23	15 30·34	33 53·7	18	52 28·89	13 0·8
24	14 29·29	29 1·8	19	51 45·98	11 54·7
25	14 13 28·22	93 24 15·9	20	13 51 4·43	92 10 59·7

1849.	R.A. h m s	N.P.D. ° ′ ″	1849.	R.A. h m s	N.P.D. ° ′ ″
May 21	13 50 24·28	92 10 15·7	June 11	13 42 15·56	92 35 50·9
22	49 45·57	9 42·3	12	42 9·68	38 53·0
23	49 8·30	9 20·2	13	42 5·37	42 4·2
24	48 32·51	9 9·5	14	42 2·60	45 24·3
25	47 58·22	9 9·4	15	42 1·41	48 52·9
26	47 25·45	9 20·3	16	42 1·79	52 30·2
27	46 54·22	9 42·0	17	42 3·69	92 56 15·9
28	46 24·54	10 14·4	18	42 7·12	93 0 9·9
29	45 56·43	10 57·7	19	42 12·08	4 12·1
30	45 29·90	11 51·7	20	42 18·55	8 22·3
31	45 4·94	12 56·1	21	42 26·53	12 40·3
June 1	44 41·57	14 11·1	22	42 35·99	17 6·0
2	44 19·80	15 36·5	23	42 46·93	21 39·4
3	43 59·62	17 12·1	24	42 59·33	26 20·0
4	43 41·05	18 57·9	25	43 13·18	31 8·0
5	43 24·06	20 53·6	26	43 28·46	36 3·0
6	43 8·67	22 59·2	27	43 45·15	41 4·9
7	42 54·87	25 14·6	28	44 3·25	46 13·6
8	42 42·67	27 39·5	29	44 22·71	51 29·0
9	42 32·05	30 14·0	30	13 44 43·55	93 56 50·8
10	13 42 23·01	92 32 57·8			

The Computed—Observed places for May 7 are about + 1ˢ·7, and + 11″, by Mr. Hartnup's observations.

The right ascensions are reckoned from the true equinox, and the places of this ephemeris, like those in the *Nautical Almanac*, should agree with the observations when these are corrected for refraction and parallax.

Horizontal Parallax.

		″			″			″
April	1	5·31	May	3	5·49	June	4	4·87
	5	5·38		7	5·45		8	4·76
	9	5·44		11	5·39		12	4·66
	13	5·49		15	5·33		16	4·55
	19	5·51		19	5·25		20	4·45
	21	5·54		23	5·16		24	4·35
	25	5·54		27	5·07		28	4·25
	29	5·52		31	4·97			

METIS.

*Ephemeris.** By Mr. Graham.

For Greenwich Mean Midnight.

1849.	R.A. h m s	N.P.D. ° ′ ″	1849.	R.A. h m s	N.P.D. ° ′ ″
May 3	21 55 47·51	107 24 25·9	May 19	22 14 26·04	106 23 48·1
4	57 2·75	20 9·9	20	15 29·36	20 39·1
5	58 17·34	15 57·1	21	16 31·82	17 35·4
6	21 59 31·25	11 47·6	22	17 33·42	14 37·2
7	22 0 44·48	7 41·6	23	18 34·14	11 44·6
8	1 57·03	107 3 39·2	24	19 33·96	8 57·6
9	3 8·87	106 59 40·5	25	20 32·88	6 16·4
10	4 19·99	55 45·8	26	21 30·89	3 41·1
11	5 30·39	51 55·0	27	22 27·96	106 1 11·8
12	6 40·05	48 8·4	28	23 24·10	105 58 48·7
13	7 48·97	44 26·0	29	24 19·28	56 31·8
14	8 57·13	40 48·0	30	25 13·49	54 21·3
15	10 4·51	37 14·5	31	26 6·72	52 17·3
16	11 11·11	33 45·7	June 1	26 58·96	50 20·0
17	12 16·90	30 21·5	2	22 27 50·20	105 48 29·3
18	22 13 21·89	106 27 2·3			

Horizontal Parallax.

	″		″		″
May 3	3·36	May 15	3·60	May 27	3·86
7	3·43	19	3·68	31	3·96
11	3·51	23	3·77	June 3	4·07

	Log. Δ		Log. Δ		Log. Δ
May 3	0·40649	May 15	0·37759	May 27	0·34643
7	39713	19	36744	31	0·33562
11	0·38748	23	0·35705		

Continuation of the Ephemeris of Metis. By Mr. Graham.

For Greenwich Mean Midnight.

1849.	R.A. h m s	N.P.D. ° ′ ″	1849.	R.A. h m s	N.P.D. ° ′ ″
June 3	22 28 40·40	105 46 45·7	June 13	22 36 2·87	105 36 13·9
4	29 29·59	45 8·9	14	36 40·74	35 54·2
5	30 17·73	43 39·3	15	37 17·37	35 42·9
6	31 4·79	42 16·9	16	37 52·74	35 40·1
7	31 50·77	41 1·8	17	38 26·84	35 46·0
8	32 35·65	39 54·3	18	38 59·64	36 0·6
9	33 19·41	38 54·4	19	39 31·13	36 24·1
10	34 2·03	38 2·3	20	40 1·28	36 56·5
11	34 43·49	37 18·1	21	40 30·08	37 38·0
12	22 35 23·78	105 36 42·0	22	22 40 57·51	105 38 28·5

* An Ephemeris of *Metis* by Dr. Gould was communicated by Professor Schumacher.

1849.	R.A. h m s	N.P.D. ° ′ ″	1849.	R.A. h m s	N.P.D. ° ′ ″
June 23	22 41 23·55	105 39 28·3	July 3	22 44 24·40	105 57 59·7
24	41 48·20	40 37·2	4	44 34·18	106 0 43·1
25	42 11·43	41 55·4	5	44 42·39	3 35·9
26	42 33·22	43 22·9	6	44 49·01	6 38·3
27	42 53·57	44 59·7	7	44 54·03	9 50·2
28	43 12·45	46 46·0	8	44 57·43	13 11·5
29	43 29·86	48 41·8	9	44 59·19	16 42·5
30	43 45·77	50 47·0	10	44 59·31	20 22·9
July 1	44 0·17	53 1·8	11	44 57·77	24 12·7
2	22 44 13·06	105 55 26·0	12	22 44 54·56	106 28 11·8

Horizontal Parallax.

	″		″		″
June 2	4·01	June 18	4·45	July 4	4·94
6	4·11	22	4·57	8	5·07
10	4·22	26	4·69	12	5·20
14	4·33	30	4·81		

"The *continuation* is from the same elements as the first portion. I have since computed fresh elements, which agree better with the observations; these are subjoined.

Epoch, May 0·0, Greenwich M.T.

	° ′ ″	
Mean Anomaly	144 9 44·3	
π	71 8 46·8	Mean Eq.
Ω	68 27 46·8	May 0·0.
i	5 35 47·1	
ϕ	7 4 0·5	
Log a	0·3776655	
μ	962″·7384	

The corrections to the ephemeris, according to these elements, are

1849.	R.A. s	N.P.D. ′ ″
May 1·0	−15·12	+1 26·6
July 20·0	−30·85	+3 18·2

HEBE.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1849.	Greenwich M.T. h m s	R.A. h m s	N.P.D. ° ′ ″	Compd—Obsd. R.A. s	Compd—Obsd. N.P.D. ″	Star. B.A.C.
April 26	9 13 47·3	6 53 50·63	70 29 53·2	+6·27	−15·8	2233–2330
28	8 57 42·1	6 56 54·93	70 25 46·6	+6·56	−11·7	2271–2350

"Corrected for refraction and parallax, and compared with M. Luther's ephemeris, published in the *Monthly Notices*, Vol. ix. No. 6."

Observations of the Elongations of the Satellites of Saturn, made during the Opposition of 1848 *with the* 20*-foot Equatoreal.* By Mr. Lassell.

"The powers generally used were 219, 297, and 366. The elongations were measured in arc of right ascension, and not in the

direction of the major axis of *Saturn's* ring. This was done for greater accuracy as well as convenience. In the earlier observations, most of the distances are deduced from differences of transits of *Saturn's* limb and the satellite, reduced to *Saturn's* centre by applying the semi-diameter from the *Nautical Almanac;* but the later measures were chiefly micrometrical—a method I greatly prefer and now constantly employ,—except in the great elongations of *Iapetus*, which are too distant for the micrometer. Owing to the present position of *Saturn's* ring, the nearer satellites did not wander sensibly from the plane of the ring; when the more distant ones were obviously out of that plane, I took differences of declination of the satellites and *Saturn's* limb, reduced to his centre.

"The sign + affixed to any measured elongation indicates that the satellite is ascertained, or believed to be receding from the planet; and the sign —, that it is approaching.

Mimas.

1848. d	
Sep. 16·42	Estimated to be at its greatest eastern elongation from *Saturn's* limb, about 1 diameter of the planet.
19·46	Estimated to be 10″ distant from the preceding limb, moving away from the planet.
21·54	Estimated to be 30° short of its greatest elongation westward.

Enceladus.

1848. d	″		
Sep. 16·45	36	E.	estimated
18·37	34	W.	,,
Oct. 17·34	28 +	W.	,,
25·46	36	W.	,,
29·43	28	W.	,,
Nov. 14·38	40	E.	,,

Tethys.

	″		
Oct. 22·45	28·7 +	E.	4 obs.
25·46	43·9 +	W.	3 ,,
29·43	38	W.	estim.
Nov. 4·35	20 —	W.	,,
14·38	49	E.	3 obs.

Hyperion.

	″		
Sep. 21·55	234	E.	
22·41	207	E.	
Oct. 20·35	178	W.	
22·44	203	W.	
Nov. 14·36	133	W.	
24·45	202·8	E.	

Dione.

1848. d	″		
Oct. 5·46	48	E.	
16·50	41	E.	3 obs.
17·34	26	E.	3 ,,
22·45	55 —	E.	4 ,,
25·46	39·6 —	E.	4 ,,
29·43	44·5 —	W.	3 ,,
Nov. 9·28	55·4 —	W.	4 ,,
14·38	50 +	W.	2 ,,
24·45	44·7 —	E.	2 ,,

Rhea.

	″		
Oct. 5·46	66	W.	
16·50	80	E.	
17·34	5 —	E.	
18·35	74 +	W.	5 obs.
20·34	64 +	E.	4 ,,
21·45	56 —	E.	5 ,,
22·45	49 +	W.	6 ,,
29·43	66·9 +	E.	3 ,,
Nov. 4·35	26 —	E.	estim.
11·26	15 +	E.	,,
14·38	69 +	W.	6 obs.
21·35	77 +	E.	3 ,,
24·45	37·2 —	W.	2 ,,

Titan.

1848.	d						
Sep.	21·54	193	E.				
Oct.	5·46	183	E.	2 obs.			
	16·50	127	—W.	3 ,,			
	17·34	76	—W.	3 ,,			
	18·35	occulted by *Saturn*.					
	20·34	134	E.	3 ,,			
	21·45	181	E.	4 ,,			
	22·45	197	E.	2 ,,			
	29·43	166·5	+W.	3 ,,			
Nov.	4·35	75·5	+E.	3 ,,			
	9·28	148	—E.	4 ,,	14·4	S.	2 obs.
	11·26	91·6	—E.	3 ,,	13·5	S.	2 ,,
	14·38	163	+W.	4 ,,	12·6	N.	1 ,,
	21·35	134	+E.	4 ,,	6·1	S.	1 ,,
	24·45	173·4	—E.	2 ,,			
	30·36	159·8	+W.	2 ,,	11·9	N.	2 ,,
Dec.	1·43	171·7	—W.	1 ,,			

Iapetus.

Sep.	21·56	439·5	E.				
	22·41	482	E.				
Oct.	5·46	513	E.		110	N.	of *Saturn's* centre.
	16·50	127	E.	3 obs.	89	N.	2 obs.
	17·34	86	E.	3 ,,			
	18·35	38	E.	5 ,,	62	N.	3 ,,
	20·34	43	W.	4 ,,			
	21·45	88	W.	5 ,,	52	N.	
	22·45	134	W.	3 ,,	45	N.	
	25·46	250	W.	3 ,,	40	N.	
	29·43	388·3	W.	2 ,,	5	N.	
Nov.	4·49	524	W.	3 ,,	30	S.	
	9·28	538·6	W.	3 ,,	61	S.	2 ,,
	11·26	534	W.	3 ,,	64·3	S.	3 ,,
	14·38	475	W.	4 ,,	76	S.	2 ,,
	21·35	266	W.	3 ,,	73·8	S.	3 ,,
	24·45	146·6	W.	2 ,,	68·8	S.	2 ,,
	30·40	104·2	E.	1 ,,	44	S.	1 ,, ?
Dec.	1·43	149	E.	1 ,, ?			

Note on the Mass of Uranus. By Mr. Adams.

"The mass of *Uranus* is a very important element in the determination of the orbit of *Neptune*. Two values of this mass have been given, differing widely from each other. Bouvard, from the action of *Uranus* on *Saturn*, found the mass to be $\frac{1}{17918}$, that of the sun being $=1$; while more recently, from observations of the satellites, Lamont has obtained the value $\frac{1}{24605}$. In order to throw light on this subject, Mr. Lassell was kind enough to make for me the observations of the satellites of *Uranus*, which are given in the *Monthly Notice* for March last.

"These I have carefully reduced, and the value of the mass which I have found from the observations of the fourth satellite (which are more to be depended on for this purpose than those of the second) is $\frac{1}{20897}$, which is almost exactly a mean between the results of Bouvard and Lamont. In obtaining this result, I have rejected the first day's observations, which are discordant both for the second and fourth satellites.

"I have also reduced all Sir Wm. Herschel's measures of distance of the satellites given in his paper in the *Phil. Trans.*, 1815, and the value of the mass obtained from the observations of the fourth satellite is $\frac{1}{21165}$, which agrees very closely with that found from Mr. Lassell's observations. Although, therefore, more numerous observations will be requisite in order to obtain a mass which may be used with confidence in the theory of *Neptune*, I have no doubt that the value $\frac{1}{21000}$ is much nearer the truth than either of those which have been previously given, and I shall accordingly employ it in my subsequent calculations respecting the orbit of *Neptune*.

"The most probable values of the periods of the second and fourth satellites, given by the combination of the observations of Sir Wm. Herschel, Sir J. Herschel, Lamont, and Mr. Lassell, are $8^{d}\cdot7058435$ and $13^{d}\cdot463139$ respectively; but the remaining errors of the epochs are greater than can with probability be ascribed to mere errors of observation, and seem to indicate the existence of considerable perturbations."

GOUJON'S COMET.

BERLIN. (Dr. Galle.)

1849.	Berlin M.T. h m s	R.A. ° ′ ″	Dec. ° ′ ″
April 26	10 20 21	165 30 59·4	+10 40 49·8
27	10 6 37	165 28 39·2	+13 51 12·3

HAMBURG. (M. G. Rümker.)

	Hamburg M.T. h m s	R.A. ° ′ ″	Dec. ° ′ ″
April 23	9 27 27·6	165 45 26·6	+ 0 28 30·6
24	8 51 41·8	39 30·3	Meridian.
May 2	10 36 1·0	30 34·1	28 4 35·8
3	10 31 54·1	33 57·3	30 29 5·9
4	10 23 53·2	38 8·8	32 44 44·7
5	10 3 3·3	43 14·9	34 51 37·5
	11 3 37·3	43 29·8	34 56 51·6
6	9 25 55·9	165 49 1·0	36 49 53·6
12	11 43 33·4	166 42 38·2	46 46 30·6
18	11 58 27	168 3 8·0	53 35 0·4
20	11 41 58·6	35 54·3	55 22 2·8
21	11 7 1·3	168 52 55·4	56 10 20·0
22	11 59 18·3	169 11 11·2	+56 59 24·7

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1849.	Greenwich M.T.	R.A.	Log. $\frac{p}{P}$	N.P.D.	Log. $\frac{q}{P}$	Star.
	h m s	h m s		° ′ ″		
April 23	11 59 36·4	11 2 56·69	+8·4320	89 3 47·1	−9·9028	*a*
26	10 55 13·0	11 2 4·00	8·3043	79 7 11·1	9·8371	*b*
27	12 31 34·1	11 1 53·07	8·5276	75 42 50·9	9·8390	*c*
28	12 27 3·6	11 1 47·37	8·5336	72 38 45·4	9·8200	*d*
30	12 29 18·1	11 1 47·99	8·5625	66 52 28·8	9·7850	*e*
May 7	10 35 29·6	11 3 44·81	8·4667	51 7 48·3	9·5008	*f*
8	11 47 53·8	11 4 16·72	8·6303	49 15 51·2	9·5781	*f*
11	13 58 22·5	11 6 11·95	+8·7542	44 26 12·2	−9·7442	*g*

a B.A.C. 3903, 3909 — *d* B.A.C. 3838
b ,, 3761, 3837 — *e* ,, 3834
c ,, 3483 — *f* ,, 3856
g ,, 3868

"The observations are corrected for refraction. The corrections to be applied for parallax in time and arc are represented by p and q. P is the equatoreal horizontal parallax.

"The light of the comet was strongly condensed towards the centre; but the nucleus was not so well defined, nor the coma so extensive, as in the Schweizer-Bond Comet. I did not observe any tail."

Elements.

M. d'Arrest has calculated elements on the following observations:—

	h m s		R.A. ° ′ ″	Dec. ° ′ ″
April 15	11 39 6	Paris.	167 7 0·0	−25 31 25·0
20	11 19 13	Altona.	166 7 57·6	− 9 36 31·2
27	9 41 23	Leipsic.	165 28 29·0	+13 48 20·2

T. 1849, May 26·43349, Berlin M.T.

π	235 31 25·3	Mean Eq.
Ω	202 30 55·0	1849·0
i	67 19 59·7	
Log. q	0·0648988	Motion direct.

"These elements represent Dr. Petersen's observations, very nearly."—*Professor Schumacher.*

Ephemeris. By M. Weyer.

For Berlin Mean Midnight.

	R.A.	Dec.	Log. Δ		R.A.	Dec.	Log. Δ
	° ′	° ′			° ′	° ′	
April 30	165 29	+23 6	9·590	May 9	166 15	+42 32	
May 1	30	25 48		10	24	44 6	
2	32	28 21		11	34	45 35	
3	36	30 46		12	45	46 59	9·735
4	41	33 2	9·635	13	166 56	48 17	
5	47	35 10		14	167 8	49 31	
6	165 53	37 11		15	21	50 41	
7	166 0	39 5		16	167 35	+51 46	9·782
8	166 7	+40 52	9·685				

From M. G. Rümker's elements, which agree pretty nearly with those of Professor Argelander.

Ephemeris of Goujon's Comet. By M. Weyer, from his own elements, which represent the Hamburg observations of May 12 thus,—

	$\Delta\alpha \cos\delta$	$\Delta\delta$
Calcul.—Obs. =	+4″·8	+5″·0

Ephemeris (for 10^h Berlin M.T.)

1849.	R.A.	N.P.D.	log. Δ	log. r	Light
	° ′	° ′			
May 20	168 34·7	34 42·4	9·8269	0·0658	0·428
21	168 52·0	33 52·8	·8372	·0653	·409
22	169 10·0	33 5·7	·8473	·0650	·391
23	28·5	32 20·7	·8571	·0646	·374
24	169 47·9	31 37·9	·8668	·0644	·358
25	170 8·0	30 57·3	·8761	·0643	·343
26	28·8	30 18·5	·8853	·0643	·329
27	170 50·3	29 41·4	·8941	·0643	·316
28	171 12·5	29 6·0	·9029	·0644	·303
29	35·4	28 32·4	·9113	·0646	·291
30	171 58·9	28 0·3	·9197	·0649	·280
31	172 23·1	27 29·5	·9277	·0652	·270
June 1	172 48·0	27 0·0	·9356	·0657	·260
2	173 13·5	26 31·9	·9432	·0662	·250
3	173 39·7	26 5·0	·9507	·0668	·241
6	175 2·7	24 50·2	·9720	·0691	·216
9	176 32·2	23 44·1	9·9918	0·0721	0·194

"The intensity of light $\left(=\frac{1}{\Delta^2 r^2}\right)$ supposes, as unity, the intensity at its discovery. Δ and r are, as usual, the distances of the comet from the earth and sun."—*Communicated by Professor Schumacher.*

SCHWEIZER'S COMET.*

This comet was discovered on April 11th, at $9\frac{1}{2}^h$ P.M., by Professor Schweizer, of Moskow, who saw it in conjunction with χ *Boötis*, and about 1° south of the star.

Professor Bond observed the comet a few hours later (see p. 128). It was discovered by Mr. Graham on the 14th. The comet had a strong, star-like, central condensation, an extensive coma, and no tail. It has been supposed to be the second comet of 1748 (No. 70), the elements of which were computed by Bessel from three imperfect observations of Klinkenberg.

* The Editor follows the authority of Professor Schumacher in naming this comet; though, under the circumstances, he would have preferred the title of Schweizer-Bond, as recalling the facts of its discovery.

CAMBRIDGE, U.S. Great Refractor. (Prof. W. C. Bond.)

1849.	Cambridge M.T. h m s	A.R. 1849·0 h m s	Dec. 1849·0 ° ′ ″	No. of Comp.	Star of Comp.
April 11	10 56 29	15 9 6·1	+28 33 27	8	*a*
12	7 57 58	15 3 36·3	28 20 9	5	*a*
	15 36 21	1 27·2	28 14 48	5	*a*
14	10 35 59	14 48 12·1	27 36 34	5	*b c*
17	8 48 52	14 20 40·6	25 54 23	3	*d*
19	9 8 51	13 56 38·9	24 0 59	5	*e*
21	8 24 56	13 28 20·5	21 20 9	8	*f*
24	8 49 33	12 35 11·4	15 4 58	8	*g*
	9 44 33	34 26·5	14 59 1	1	*h*
26	8 36 58	11 55 3·1	9 25 5	5	*i*
27	10 20 28	11 32 32·6	+ 5 59 3	10	*k*
May 1	10 36 46	10 11 15·6	− 7 1 48	4	*l*
2	9 36 6	9 53 54·3	9 44 28	5	*m*
10	8 47 49	8 11 17·9	−23 26 34	2	*n*

Referred to the mean equinox of 1849·0.

Mean Places of Stars of Comparison for 1849·0.

			R.A. h m s	Dec. ° ′ ″	Mag.	
a	B.Z.	366	15 6 23·25	+28 30 5·3	8·9	Star double, *nf* used.
b	,,	366	14 48 7·66	27 25 9·5	9	By intermediate star, 13th mag.
c	,,	366	14 51 39·77	27 25 25·7	8	
d	,,	462	14 16 16·33	26 1 29·9	7	
e	,,	412	13 59 19·81	24 6 46·3	8	
f	,,	460	13 27 28·03	21 25 18·4	9	Mean with H.C. 25118.
g	,,	360	12 37 49·79	15 11 35·5	8	
h	,,	360	12 34 26·48	14 59 21·1	9	Comet 20″ from the star.
i	B.A.C.	4072	11 57 31·10	9 34 17·7	3	By an intermediate star.
k	Weisse	573	11 32 43·06	+ 5 58 37·1	8	Mean with H.C 22110.
l	H.C.	20153	10 15 44·05	− 7 0 45·6	8	By an intermediate star.
m	B.Z.	217	9 54 44·82	9 42 19·8	8	
n	B.A.C.	2827	8 18 33·01	−23 33 31·2	6	

"The comet has usually presented an apparently solid but very minute central point, admitting of accurate observation."

PULKOWA. (M. Otto Struve.)

1849.	Pulkowa Sid. T. h m s	R.A. h m s	Par.	Dec. ° ′ ″	Par.
April 17	11 59 50·7	14 23 7·04	−·0219 P	+26 4 8·7	+·597 P
19	15 23 49·3	13 57 56·51	+·0135	24 7 26·9	·597
23	11 57 40·7	12 58 21·75	−·0095	17 59 38·6	·672
26	12 38 41·5	11 59 25·41	+·0058	10 3 42·4	·764
27	12 36 52·2	11 38 35·72	·0086	6 54 49·0	·799
28	12 43 37·5	11 17 29·61	·0125	3 36 5·3	·833
29	13 48 58·6	10 55 45·31	·0231	+ 0 6 47·3	·863
May 1	14 0 34·6	10 15 59·28	+·0278 P	− 6 17 19·1	+·890 P

On May 1 the comet was compared with a star the place of which was taken from B.A.C. and Bessel's zones; for the previous days the stars of comparison have been determined by meridian observations. M. Otto Struve saw the comet with the naked eye as bright as 4·5 mag. star.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1849.	Greenwich M.T. h m s	R.A. h m s	N.P.D. ° ′ ″	Star.
April 26	11 16 4·4	11 56 52·53	80 18 34·7	4168 B.A.C.
,,	13 28 49·0	54 57·34	80 35 37·1	4114 ,,
28	11 38 25·2	14 32·14	86 51 37·0	3900 ,,
,,	11 53 43·1	11 14 18·99	86 53 51·6	— ,,

"Corrected for refraction and parallax. The horizontal parallax is taken from Mr. Graham's ephemeris. The comet had a well-defined nucleus of about 2″ diameter, surrounded by a strong nebulous light, and no tail could be seen."

HAMBURG. (M. Rümker.)

1849.	Hamburg M.T. h m s	R.A. h m s	Dec. ° ′ ″
April 20	11 7 35·4	13 44 54·91	+22 57 40·1
23	10 43 9·7	12 56 41·57	17 47 28·6
24	9 52 43·8	38 43·27	15 32 4·5
25	9 26 37·4	12 19 27·35	12 56 37·4
29	10 5 5·9	10 55 38·24	+ 0 5 50·0

BERLIN. (Dr. Galle.)

1849.	Berlin M.T. h m s	R.A. ° ′ ″	Dec. ° ′ ″
April 23	10 46 37	194 12 2·6	+17 48 36·9*
26	9 51 39	179 42 53·5	9 58 45·4
27	9 17 3	174 36 46·1	+ 6 53 23·4

Elements.

	M. Hensel (Leipsic).	Dr. Luther.
T.	1849, June 8·21239, Berlin M.T.	1849, June 8·21067, Berlin M.T.
	° ′ ″	° ′ ″
π	267 4 22·8 } Mean Eq.	267 4 12·91 } Mean Eq.
Ω....	30 31 51·1 } 1849·0.	30 31 49·74 } 1849·0.
i.....	66 57 56·9	66 57 32·16
Log. q	9·951550	9·9515556

Motion direct.

* This observation is corrected.

Dr. d'Arrest has calculated elements on the same observations, and finds no sensible difference from M. Hensel's elements, which represent the observations nearly completely.

M. Hensel's elements are deduced from the corrected observations of Mr. Graham, April 14; Dr. Petersen, April 20; Dr. Galle, April 16. Dr. Luther has calculated his elements on the observations of April 14, 20, 26, not taking parallax into account.

Parabolic, J. D. Runkle.		Hyperbolic, G. P. Bond.	
Perihelion Pass., June 8·18828, G.M.T.		June 6·7547, G.M.T.	
Long. Per...	267 ° 3 ′ 33 ″	265 ° 17 ′ 43·5 ″	Mean Eq.
,, Node.	30 32 53	30 21 6·3	1849·0.
Inclination..	66 54 10	68 14 40·2	
log. Per. Dist.	9·9513114	9·9557110	
Motion direct.		Eccentricity 1·0670345	Motion direct.

"It is to be hoped that observations after the perihelion may be obtained, to determine whether there be a decided eccentricity to the orbit. The above hyperbola deviates about 1′ 30″ of arc from the observation on May 10th. (*From Professor Bond.*)

"We obtained a place of a star of the 12th mag., supposed to be *Metis*, April 12th, $16^h\ 26^m\ 22^s$, Cambridge M.T.

R.A. $21^h\ 27^m\ 32^s{\cdot}97$ } Mean Eq.
Dec. $-19°\ 2'\ 22''{\cdot}9$ } Jan. 1st, 1849.

"It has been observed two or three times since, but with great difficulty in distinguishing it from fixed stars of the 12th and 13th magnitudes."

Ephemeris. By Dr. Luther. From his own Elements.

Berlin Mean Noon.

1849.	R.A. ° ′ ″	Dec. ° ′ ″	Log. Δ
April 8	231 56 51·9	+29 6 44·5	9·707595
12	226 48 3·3	28 28 55·4	·630195
16	219 11 27·0	26 51 33·3	·542472
20	207 52 34·9	23 34 0·9	·446923
24	191 40 6·7	16 33 39·4	·357808
28	171 22 16·0	+ 4 52 31·0	·312269
May 2	151 18 24·6	− 7 58 44·1	·342196
6	135 26 22·4	17 17 51·5	·422728
10	124 10 0·4	22 51 13·8	·513826
14	116 14 4·4	−26 6 33·8	9·598063

On calculating the Moon's Place for Ephemerides.
By S. M. Drach, Esq.

In this paper (read at the last April meeting) the author shews that by a modification of Burckhardt's method the lunar co-ordinates are obtainable with a less degree of labour and number

of equations; for this purpose adding the sexagesimal equations in seconds to the argument of the next inequality, the circumference of which is divided into 16,000,000 parts. The arguments are likewise increased by twice or thrice the annual equation, which, if attended to by Burckhardt, would have removed some of his principal 32 small equations, allowing several of them to be condensed into one table of double entry. As the paper chiefly consists of algebraical formulæ and numerical calculations, it could be only *announced* to the meeting.

On the Determination of the most probable Orbit of a Binary Star from the assemblage of a great number of observed Angles of Position. By Sir J. F. W. Herschel, Bart. *With some Remarks by the President on a Solution of the same Problem by M. Yvon Villarceau.*

In this paper Sir John Herschel refers generally, for the principle of his method, to a paper published by him in the fifth volume of the *Memoirs* of this Society, the paper (we may remark) in which was given an exposition of the principles by which the orbit of a double star was for the first time actually determined. He now states his conviction that the method there expounded is, on the whole, the best that can be employed; and the object of the present paper is, retaining the original principle (namely, of using only the measured angles of position, and rejecting entirely the measures of distance), and retaining the first step of the original method (namely, of smoothing down the irregularities of the angles as measured, by laying them down graphically, the angles for abscissæ and the corresponding times for ordinates, and then drawing a curve by hand through the points so found, and using that curve as the representation of the real relation between the angles and the times, and measuring from it the times corresponding to angles which differ by 5°, or by 10°, or any other convenient difference); retaining the original method thus far, to complete the investigation by a process entirely algebraical and arithmetical.

Supposing the times corresponding to equal intervals of angle to be taken from the curve above mentioned, the next thing required is $\frac{dt}{d\theta}$ for every 5° or every 10°, &c. This is to be found by the following formula, which requires for application only the finite differences of t for the equidistant values of θ,

$$\frac{dt}{d\theta} = \frac{1}{\Delta\theta}\left\{\frac{\Delta t}{1} - \frac{\Delta^2 t}{2} + \frac{\Delta^3 t}{3} - \&c.\right\}$$

The next step is, to infer from this the true apparent distance of the stars, as it ought to be measured by a perfect micrometer or measuring instrument. Now every determination of an orbit of double stars proceeds on the assumption of an attraction between the two components, and this requires the supposition of descrip-

tion of areas proportional to the time, both in the orbit really described and in the projection of the orbit which we see. Hence we must have $\varrho^2 . \frac{d\theta}{dt} = \text{constant} = 100$ (the unit of the radius vector being for the present arbitrary), and therefore $\varrho = \sqrt{100 . \frac{dt}{d\theta}}$ or $= \sqrt{-100 \frac{dt}{d\theta}}$, according as $\frac{d\theta}{dt}$ is positive (that is, θ increasing in the direction $n f s p$) or negative. Sir John adopts for the unit of angles one degree, and for the unit of time one year.

A series of radii vectores being thus found, corresponding to certain values of θ, the next step is to form from these in numbers the corresponding values of the rectangular co-ordinates $x = \varrho . \cos \theta$ $y = \varrho . \sin \theta$. And, assuming that the force of attraction between the two stars follows the law of the inverse square of the distance, and therefore that the curve really described is a curve of the second order, and consequently that the apparent curve is a curve of the second order, we must make these numerical values of x, y, (as $x_1 y_1$, $x_2 y_2$, $x_3 y_3$, &c.) satisfy the equation $o = 1 + \alpha x + \beta y + \gamma x^2 + \delta x y + \varepsilon y^2$, an equation containing 5 unknown constants. As the number of equations will generally exceed 5, it will be proper to combine them by the method of least squares; and the only question is, what is the function of x and y which shall be supposed *à priori* liable to equal error in all? Sir John Herschel tacitly assumes that the function $B = 1 + \alpha x + \beta y + \gamma x^2 + \delta x y + \varepsilon y^2$ is the quantity which with equal weight throughout is to be made as small as possible, or that $\Sigma (B^2)$ is to be minimum. The equations given by this consideration are easily formed, and then α, β, γ, δ, ε, can be determined.

From these numbers the numerical values of the more convenient elements of the apparent ellipse may be found, and from them the elements of the real ellipse may be found. The formulæ for all these transformations are given at length by Sir John Herschel, and they are less complicated than might at first have been feared.

Thus far the elements necessary to produce geometrical coincidence of the concluded orbit with the observed orbit are alone determined. The next operation is to determine those elements which relate to the motion in the concluded orbit. For this purpose, angles being taken from the curve based on the graphical projection, and these angles (which relate to the apparent orbit) being converted into angles in the true orbit by the formulæ lately found, and thus exhibiting true anomalies on the true ellipse, the excentric anomalies are found at once by the formula $u - e \sin u$, and the mean anomalies are found. Then every one of these angles gives an equation of the form

$$w_1 = k . t_1 - l,$$

from the assemblage of which the constants k and l can be found by the method of least squares; and then we have all that is required to form the mean anomaly for any other time t, and con-

sequently (as the elements of the ellipse are known) to form the excentric and true anomalies.

The conversion of a place thus computed in the real orbit into one in the apparent orbit, and the comparison of the distance computed on the arbitrary scale with the distance measured with the micrometer, and the inference as to the true value of the units of the arbitrary scale, are steps which require no particular explanation.

Sir John Herschel holds out the hope of following up this exposition with the details of the application of his method to the star γ *Virginis*.

As an Appendix to Sir John Herschel's paper, it is proper to add that papers have been received by Sir John Herschel from M. Yvon Villarceau (namely, a note on the double star ζ *Herculis*, dated 1849, February 1, a note on the double star η *Coronæ*, dated 1849, March 30, and a letter dated 1849, April 1, containing an exposition of M. Yvon Villarceau's methods), which have been communicated more or less completely to the *Académie des Sciences* of France, and which therefore cannot be received in the ordinary way as a communication to this Society. It is, however, the wish, both of Sir John Herschel and of M. Yvon Villarceau, and it appears in every way desirable, that their results should be made known to this Society, both as containing instructive expositions of a very elegant general method and very curious applications of it, and also as bearing upon any questions which may arise as to the similarity or priority of the methods of Sir John Herschel and M. Yvon Villarceau.

Assuming the law of gravitation, and consequently the law of elliptic movement, as applying generally to the relative motion of two stars in a binary system, M. Yvon Villarceau remarks that the projection of this curve upon the spherical sky (or rather upon a plane perpendicular to the visual ray) will be a curve of the second order, whose equation will be,

$$F = ay^2 + bxy + cx^2 + dy + ex + f = o,$$

the origin of co-ordinates being one star regarded as a fixed centre of attraction of the other. The object of the next process must be, to adopt this general equation to the particular observations from which the orbit is to be deduced: and here it is to be observed that M. Villarceau does not confine himself either to the measured angles of position or to the measured distances, but uses both, for the formation of the numerical values of x and y corresponding to every observation. Having these numerical values of rectangular co-ordinates, and paying no respect (for the present) to the intervals of time between the observations, the following is the method used to accommodate *geometrically* the curve of the second order to the observed co-ordinates:—

The principle assumed is, that the constants a, b, c, &c. shall be so determined that if the resulting curve be drawn, and if from

every observed place a normal (usually a very short line) be drawn to the curve, then the sum of the squares of these normals, each multiplied by its proper weight, shall be a minimum. This principle, it is almost unnecessary to remark, is imperfect, inasmuch as it does not in any way take cognisance of the laws of movement as connected with *time;* but it will frequently be doubtful, in a problem of such difficulty, whether it is not best to neglect a condition, even of the most essential kind, for the sake of making the solution more simple.

Putting $b^2\,D^2$ for $\left(\frac{dF}{dx}\right)^2+\left(\frac{dF}{dy}\right)^2$, and p for the weight of each determination, M. Villarceau arrives thus at the following equations:—

$$\Sigma\,.\,\frac{p\,F\frac{dF}{da}}{D^2}=0,\text{ or }\Sigma\,.\,\frac{p\,y^2\,F}{D^2}=0$$

$$\Sigma\,.\,\frac{p\,F\frac{dF}{db}}{D^2}=0,\text{ or }\Sigma\,.\,\frac{p\,x\,y\,F}{D^2}=0$$

&c.,

and he shews how, supposing an ellipse roughly drawn by hand, the value of D may be found graphically; and it will then be possible to solve the equations.

The projected ellipse being thus determined, the real ellipse will be found from the consideration that the origin of co-ordinates is the projection of the focus of the real ellipse, while the centre of the observed ellipse is the projection of the centre of the real ellipse. The formation of the corresponding equations is a not difficult problem of analytical geometry. This transformation, however, is not required till all the other operations are completed.

The points determined by observation are not generally found exactly upon the projected ellipse. In order to have points upon the ellipse which shall be the subjects of further investigation, M. Villarceau transfers the observed points to the ellipse by drawing normals to the ellipse, and taking, instead of the point actually determined by observation, the foot of its normal. If x' and y' be the co-ordinates determined from observation, x and y those of the foot of the normal, then

$$x=x'-\frac{\frac{dF}{dx}}{\left(\frac{dF}{dx}\right)^2+\left(\frac{dF}{dy}\right)^2}\,.\,F\,(x',y')$$

$$y=y'-\frac{\frac{dF}{dy}}{\left(\frac{dF}{dx}\right)^2+\left(\frac{dF}{dy}\right)^2}\,.\,F\,(x',y')$$

with sufficient exactness.

The next point is, to introduce the consideration of time; and this is to be done by making the areas described by the radius vector in the projected ellipse proportional to the time. The areas can be expressed in terms of the corrected co-ordinates and the constants without much difficulty, the whole of these admitting of further correction if necessary. M. Villarceau remarks that if there are four observed places, the solution of the four equations $F(x, y) = 0$ will give four of the quantities a, b, c, d, e, in terms of the fifth; that these four observations will give three areas between which there are two equations of proportion; and that thus, besides the determination of the fifth coefficient, we shall have an equation of condition which must be satisfied, or whose failure will prove that our operations or assumptions are in some part erroneous. When there are more than four equations, all can be used in methods analogous to those which are well understood in other investigations, for correcting the result.

We must, however, express our opinion that this part of the operation appears the most obscure, as well as the most delicate and difficult, of the whole.

M. Villarceau remarks that the final determination of elements will in all cases require observations separated by a considerable interval from the rest.

M. Villarceau has lately communicated to the *Académie* another method.

The following are the principal results in the two cases which M. Yvon Villarceau has specially examined:—

In the instance of ζ *Herculis*, the stars are so unequal that there can be no possibility of confusion between the two. It was seen double in 1782, but there is reason to think that it was seen as only one star between 1795 and 1802, and also between 1828 and 1832. M. Struve, expressing himself very doubtful, seemed to suppose that the periodic time might be about 14 years. (See the *Mensuræ Micrometricæ*.) A valuable series of observations, however, having been made at Pulkowa, extending to 1847, the whole of which have been communicated to M. Yvon Villarceau, he has deduced from them an orbit in which the excentricity $= \sin 27^\circ$ nearly, and the periodic time is $36\frac{1}{3}$ years. The measure of 1782 and those from 1826 to 1847 appear to be represented with all desirable exactness. (In comparing the computed and observed angles of position, we are glad to see that M. Villarceau has converted their effects into expressions measured by seconds of arc.) The remarks, too, made by M. Struve about the time of the union of the two stars observed by him correspond exactly to the positions given by M. Villarceau's elements. Those of Sir W. Herschel do not correspond. M. Villarceau suggests that, at a time when the small star really was hidden, Sir W. Herschel may have been misled by a false image of the large star; and that, when the image of the star was deformed, he may have estimated the deformation in the wrong direction. He desires, however, specially to submit these conjectures to the judgment of Sir John Herschel; and we

trust that Sir John Herschel will not decline to undertake the honourable task to which he is invited.

M. Villarceau concludes with pointing out that this star presents a remarkable illustration of the amount of uncertainty which may rest upon the determination of double-star elements, when based upon a limited series of observations. If we had only to satisfy the observations extending from 1828 to 1847 (or through more than one-half of a revolution), we might have represented them by systems of elements in which the excentricity varies from 0·44 to 1·63, that is, the orbit might have been an ellipse, a parabola, or a hyperbola.

In the instance of *η Coronæ* there is a difficulty of a totally different kind. The two stars are so very nearly equal in magnitude and similar in colour, that, when observations are interrupted for a long time, it is impossible to say whether that which is adopted as the zero-star before and after the interruption is the same; and it is therefore necessary in some cases to make double computations, on the two suppositions that the first star, or the second star, is that to which the measures are referred in other observations.

From the observations to which they had access, M. Struve, Sir John Herschel, and M. Mädler, concluded that the periodic time of this star was 43 or 44 years. M. Villarceau, however, has had access to the observations made at Pulkowa from 1826 up to 1847, and has treated them in the following manner:—

Of fifteen observations, four were rejected, on account of manifest errors in the distance only. From the remaining eleven, relations were obtained between the elements, which leave them dependent upon an indeterminate quantity which is arbitrary between very wide limits. The observations of Sir John Herschel in 1823, and of M. Struve from 1826 to 1847, may be represented with sufficient accuracy by ellipses in which the periodic time ranges from 38 to 190 years. To fix this indeterminate quantity, we may take Sir W. Herschel's observation of 1781 or that of 1802 (with a slight alteration sanctioned by Sir John Herschel). If we fix the indeterminate quantity by the observation of 1802, M. Villarceau finds that the observation of 1781 is also satisfied, provided that the position of the stars be reversed; that is, provided that it be assumed that the other star has been used as the zero, which is perfectly admissible. Thus is obtained an orbit with a periodic time of 66 years.

But if we reverse the position of the stars in 1802, which is admissible, it is found that the observation of 1781 is satisfied without reversion. The periodic time thus obtained is 43 years.

It is remarkable that in these totally different solutions the excentricity is sensibly the same, namely, 0·47.

In both cases the remaining errors are so small, in comparison with the probable errors, as to leave the two solutions equally entitled to our reception. For the final judgment between them, M. Villarceau refers to some remarks of Sir W. Herschel, unaccompanied by measures. Although there is some doubt in the

interpretation of these, M. Villarceau thinks that upon the whole the solution which gives a period of 66 years is the more probable. He remarks, however, that in four years at the furthest the doubt will be settled. In 1853·677 the angle of position given by the 66-year solution will be 303° 44′, while that given by the 43-year solution will be 356° 30′, leaving a difference upon which there can be no doubt. The distances will be respectively 0″·51 and 0″·77, but between these it might be difficult to pronounce.

On the Practicability and Advantages of obtaining a Sea-rate for a Chronometer. By H. Toynbee, Esq., late Commander of the Ellenborough, East Indiaman.

Having found by experience that lunar observations taken Sun E. and Sun W.* give very different Greenwich Times, Capt. Toynbee has adopted the following method of combining his results in settling the rate and error of his chronometer:—

Having made numerous careful sets of lunar distances, Sun E. and Sun W., whenever an opportunity occurred, Captain Toynbee works out the error and rate of his chronometer as in the following instance. Having found from the means of several sets on several days,

	Sun E. of Moon. Error Chron.		Sun W. of Moon. Error Chron.
1848. d	m s	d	m s
Aug. 24·0	−3 31·4	Sept. 3·4	−6 1·3
Sept. 18·5	−6 52·2		
Loss in 25·5	−3 20·8	Daily rate	−0m 7s·88

Now, bringing up the error found on Sept. 3·4, Sun W., by 15·1 × −7s·88, or 1m 59s·0, we have the following chron. errors:—

d		m s
Sept. 18·5	Sun E., Chron. slow	6 52·2
	Sun W.	8 0·3
	Mean	7 26·3

With this final error for Sept. 18·5 and rate −7s·88, the chronometer being brought up to October 1st, was found to be slow 9m 4s·8; the flash of the signal-gun at Madras shewed it actually slow 9m 20s·3, *i. e.* the error in longitude was only about 4′. It should be remarked that the chronometer had fallen from its stand in a gale of wind on August 20th, and that Madras was made without reference to any other rate or error than that deduced above, *i. e.* from lunar distances observed after the accident.

A more extended series is added to shew the coincidence of the partial results obtained by Capt. Toynbee on his return:—

* There are many reasons why lunar distances from the sun are preferred to those from the planets and stars, and we believe they are more commonly observed.

1848.	d	Sun E. of Moon. Chron. Error. m s	1849.	d	Sun W. of Moon. Chron. Error. m s
Dec.	20·3	−18 29·0	Jan.	0·4	−20 45·4
1849.					
Jan.	17·2	22 11·2		30·3	24 35·0
Feb.	16·6	25 59·9	March	0·8	28 15·7
March	18·4	−30 1·0		27·0	−31 37·3

from which the following daily rates were concluded, viz.,

Sun E. $-7^s{\cdot}96$, $-7{\cdot}52$, $-8^s{\cdot}09$; Sun W. $-7^s{\cdot}68$, $-7^s{\cdot}48$, $-7^s{\cdot}69$

The final chronometer-errors are found thus:—The error, Sun E., of Dec. 20·3, is brought up to Jan. 0·4 by the rate $-7^s{\cdot}96$, and a mean is taken between this and the error actually obtained, Sun W., at the same date. In the same way the error, Sun W., on Jan. 0·4, is brought up to Jan. 17·2 by its proper rate $-7{\cdot}68$; and a mean is taken between this and the error, Sun E., at the same date. Thus Capt. Toynbee finds, for the final errors of his chronometer,

1849.	d	Chron. Error. m s	1849.	d	Chron. Error. m s
Jan.	0·4	−20 21·4	March	0·8	−27 53·4
	17·2	22 35·2		18·4	30 19·5
	30·3	24 13·4		27·0	−31 22·2
Feb.	16·6	−26 22·5			

The *actual* error, on March 27 = −31 13·6

Capt. Toynbee says: "I felt such confidence in my chronometer (Dent, 1735), corroborated as it was by all the lunar observations taken during the voyage, that on my return to England, though no land had been seen since leaving Cape Town—a northerly gale blowing as I entered the English Channel—I ventured to steer for passing within a few miles of St. Agnes Light, and sighted it in the middle of the night, bearing as my calculation had led me to expect."

The sextant employed was by Cary, with blue glasses; and care was taken that the telescope was always drawn out to the same length, the wires always in the same position, the elevating screen always raised the same quantity, and the same shades invariably used for the observation itself, and for the determination of index-error. The measured semidiameter of the sun seldom agreed with the *Nautical Almanac* nearer than within 3″ or 4″; and the lunar distances, Sun E., generally made the chronometer from 40^s to 50^s faster than the lunar distances Sun W.*; but, from the mode of treatment, errors of this kind have no influence on the rates or on the concluded errors.

Capt. Toynbee adds: "I have hitherto limited myself to observations of the sun and moon, but in a future voyage it is my intention to apply the same method to the angular distances between the moon and the planets and stars, which will probably allow of a rate being determined at an earlier period of a voyage." If the observations can be as well made, the results would certainly be

* This looks like a constant error in the observer, or in the dark shade. The results from different *distances* seem accordant.

preferable, since the final error would be obtained immediately; and if the east and west distances were properly combined, the instrumental errors and errors of observation would be eliminated. This is indeed the practice of the best navigators, who do not regard a little extra trouble when the safety of their vessel is in question, and of all competent observers who use lunars in geographical determinations.

In pointing out the advantages of this method of rating, its *independence* is very properly insisted upon. The seaman who employs it relies on his shore-rate for a very short time, and has a sufficient check even upon that. Capt. Toynbee thinks (and it is an almost universal opinion) that the sea-rate of a chronometer differs considerably from the shore-rate; and this is probably true to some extent, in some cases, though Mr. Hartnup, from his experience at Liverpool, has come to a different conclusion. As a general rule, Mr. Hartnup finds that a first-rate chronometer, which is not exposed to *sudden* changes of temperature, goes at sea, keeping pretty nearly the same rate as in his observatory, *at the same temperature*, if it rests nicely in its gimbals. It is presumed that a steady place is selected for the chronometers, and that they are not exposed to extraordinary magnetic influence.

Captain Toynbee found the rate altered by disturbing his cargo. It was about $-7^{s}\cdot8$ before his arrival at Calcutta, and kept steady for a few days until the ship began to discharge, when it gradually changed to $-6^{s}\cdot5$. The old rate was, however, taken up again at sea.

Ephemeris of Iris. By Mr. Pogson.

For 12^{h} Greenwich M.T.

1849.	R.A. h m s	N.P.D. ° ′ ″	H.P. ″	1849.	R.A. h m s	N.P.D. ° ′ ″	H.P. ″
May 16	9 48 36·81	83 5 44·9	3·56	June 19	10 24 49·73	85 28 32·7	
18	50 24·56	11 12·1		21	27 15·14	39 52·9	2·92
20	52 15·40	17 3·8	3·47	23	29 42·00	85 51 30·0	
22	54 9·22	23 19·5		25	32 10·24	86 3 23·6	2·86
24	56 5·88	29 58·8	3·39	27	34 39·78	15 33·2	
26	9 58 5·27	37 1·2		29	37 10·57	27 58·4	2·81
28	10 0 7·26	44 26·2	3·31	July 1	39 42·54	40 38·6	
30	2 11·71	83 52 13·2		3	42 45·65	53 33·5	2·77
June 1	4 18·52	84 0 21·8	3·24	5	44 49·82	87 6 42·5	
3	6 27·54	8 51·3		7	47 25·02	20 5·1	2·72
5	8 38·70	17 41·4	3·17	9	50 1·20	33 40·0	
7	10 51·90	26 51·6		11	52 38·34	87 47 29·9	2·68
9	13 7·07	36 21·5	3·10	13	55 16·40	88 1 31·5	
11	15 24·12	46 10·6		15	10 57 55·37	15 45·8	2·64
13	17 42·98	84 56 18·6	3·04	17	11 0 35·21	30 12·6	
15	20 3·58	85 6 45·2		19	11 3 15·91	88 44 51·9	2·60
17	10 22 25·85	85 17 30·0	2·98				

"The right ascension is reckoned from the true equinox, and the ephemeris is corrected for aberration."

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